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CLAIMS:

What is claimed is:

1 1. A method of balancing path usage over a plurality of  
2 paths from at least one first device to a plurality of  
3 second devices, comprising:

4 determining a total path usage for each of the  
5 plurality of paths; and

6 performing path balancing if a difference in a total  
7 path usage of a path having a highest path usage and a  
8 total path usage of a path having a lowest path usage is  
9 greater than a threshold usage amount.

1 2. The method of claim 1, wherein the path balancing  
2 includes:

3 identifying a highest path from the plurality of  
4 paths, the highest path having a highest total path  
5 usage;

6 identifying a lowest path from the plurality of  
7 paths, the lowest path having a lowest total path usage;  
8 and

9 calculating a difference between the total path  
10 usage of the highest path and the lowest path to form a  
11 calculated difference.

1 3. The method of claim 2, wherein each of the plurality  
2 of second devices is associated with at least one of the  
3 plurality of paths and wherein the path balancing

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4 includes moving a second device from the highest path to  
5 the lowest path based on the calculated difference.

1 4. The method of claim 3, wherein the second device  
2 remains unmoved if a number of moved second devices is  
3 equal to or greater than a move limit.

1 5. The method of claim 3, wherein the second device  
2 that is moved is the second device from the plurality of  
3 second devices that has a usage amount closest to a  
4 target amount.

1 6. The method of claim 5, wherein the target amount is  
2 a fraction of the difference of the total path usage of  
3 the highest path and the lowest path.

1 7. The method of claim 1, wherein the total usage for  
2 each path is a function of the total usage for each  
3 second device associated with each path.

1 8. The method of claim 7, wherein the total usage for  
2 each second device is a function of a total number of  
3 input/output messages directed to each second device  
4 multiplied by the expected connect time for the  
5 input/output messages.

1 9. The method of claim 8, wherein the expected connect  
2 time for the input/output messages is based on the type  
3 of input/output message being sent.

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1 10. The method of claim 1, wherein determining a total  
2 path usage for each of the plurality of paths includes  
3 sampling a number of I/O messages issued over each of the  
4 paths during a sampling period.

1 11. The method of claim 3, wherein moving the second  
2 device from the highest path to the lowest path based on  
3 the calculated difference includes changing address  
4 information for the second device.

1 12. The method of claim 4, wherein the move limit is set  
2 to one half the number of paths.

1 13. The method of claim 4, wherein if only one second  
2 device is associated with the highest path, movement of  
3 the one second device to the lowest path is prohibited.

1 14. A method of balancing communication path usage over  
2 a plurality of communication paths from at least one open  
3 system device to a plurality of peripheral devices,  
4 comprising:

5 calculating a total path usage for each of the  
6 plurality of communication paths;

7 identifying a highest communication path from the  
8 plurality of communication paths, the highest  
9 communication path having a highest total path usage;

10 identifying a lowest communication path from the  
11 plurality of communication paths, the lowest  
12 communication path having a lowest total path usage;

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13           calculating a difference between the total path  
14 usage of the highest communication path and the lowest  
15 communication path to form a calculated difference; and  
16           moving a peripheral device associated with the  
17 highest communication path from the highest communication  
18 path to the lowest communication path based on the  
19 calculated difference.

1   15. The method of claim 14, wherein the peripheral  
2 device remains unmoved if a number of moved peripheral  
3 devices is equal to or greater than a move limit.

1   16. The method of claim 14, wherein the peripheral  
2 device that is moved is the peripheral device from the  
3 plurality of peripheral devices that has a usage amount  
4 closest to a target amount.

1   17. The method of claim 16, wherein the target amount is  
2 a fraction of the difference of the total path usage of  
3 the highest communication path and the lowest  
4 communication path.

1   18. The method of claim 14, wherein the total usage for  
2 each communication path is a function of the total usage  
3 for each peripheral device associated with each  
4 communication path, respectively.

1   19. The method of claim 18, wherein the total usage for  
2 each peripheral device is a function of a total number of  
3 input/output messages directed to each peripheral device,

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4 respectively, multiplied by the expected connect time for  
5 the input/output messages.

1 20. The method of claim 19, wherein the expected connect  
2 time for the input/output messages is based on the type  
3 of input/output message being sent.

1 21. The method of claim 14, wherein calculating a total  
2 path usage for each of the plurality of communication  
3 paths includes sampling a number of input/output messages  
4 issued over the plurality of communication paths during a  
5 sampling period.

1 22. The method of claim 14, wherein moving the  
2 peripheral device from the highest path to the lowest  
3 path based on the calculated difference includes changing  
4 address information for the peripheral device.

1 23. The method of claim 15, wherein the move limit is  
2 set to one half the plurality of communication paths.

1 24. The method of claim 15, wherein if there is only one  
2 peripheral device associated with the highest path,  
3 movement of the one peripheral device to the lowest path  
4 is prohibited.

1 25. A computer program product in a computer readable  
2 medium for balancing path usage over a plurality of paths  
3 from at least one first device to a plurality of second  
4 devices, comprising:

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5 first instructions for determining a total path  
6 usage for each of the plurality of paths; and  
7 second instructions for performing path balancing if  
8 a difference in a total path usage of a path having a  
9 highest path usage and a total path usage of a path  
10 having a lowest path usage is more than a threshold usage  
11 amount.

1 26. The computer program product of claim 25, wherein  
2 the second instructions further include:  
3 instructions for identifying the highest path from  
4 the plurality of paths, the highest path having a highest  
5 total path usage;  
6 instructions for identifying the lowest path from  
7 the plurality of paths, the lowest path having a lowest  
8 total path usage; and  
9 instructions for calculating a difference between  
10 the total path usage of the highest path and the lowest  
11 path.

1 27. The computer program product of claim 26, wherein  
2 each of the plurality of second devices is associated  
3 with at least one of the plurality of paths and wherein  
4 the second instructions include instructions for moving a  
5 second device from the highest path to the lowest path  
6 based on the difference.

1 28. The computer program product of claim 25, wherein  
2 the first instructions include instructions for sampling

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3 a number of I/O messages issued over each of the  
4 plurality of paths during a sampling period.

1 29. The computer program product of claim 27, wherein  
2 the instructions for moving the second device from the  
3 highest path to the lowest path based on the calculated  
4 difference includes instructions for changing address  
5 information for the second device.

1 30. A path balancing apparatus that balances the path  
2 usage over a plurality of paths from at least one first  
3 device to a plurality of second devices, comprising:  
4 a controller that accumulates a total path usage for  
5 each of the plurality of paths; and  
6 a path balancing device that performs path balancing  
7 if a difference in a total path usage of a path having a  
8 highest path usage and a total path usage of a path  
9 having a lowest path usage is more than a threshold usage  
10 amount.

1 31. The apparatus of claim 30, wherein the path  
2 balancing device performs path balancing by:  
3 identifying a highest path from the plurality of  
4 paths, the highest path having a highest total path  
5 usage;  
6 identifying a lowest path from the plurality of  
7 paths, the lowest path having a lowest total path usage;  
8 and  
9 calculating a difference between the total path  
10 usage of the highest path and the lowest path.



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1 32. The apparatus of claim 31, wherein each of the  
2 plurality of second devices is associated with at least  
3 one of the plurality of paths and wherein the path  
4 balancing device moves a second device from the highest  
5 path to the lowest path based on the difference.

1 33. The apparatus of claim 32, wherein the path  
2 balancing device does not move the second device if a  
3 number of moved second devices is equal to or greater  
4 than a move limit.

1 34. The apparatus of claim 32, wherein the second device  
2 that is moved by the path balancing device is the second  
3 device from the plurality of second devices that has a  
4 usage amount closest to a target amount.

1 35. The apparatus of claim 34, wherein the target amount  
2 is a fraction of the difference between the total path  
3 usage of the highest path and the lowest path.

1 36. The apparatus of claim 30, wherein the total usage  
2 for each path is a function of the total usage for each  
3 of the plurality of second devices associated with each  
4 path.

1 37. The apparatus of claim 36, wherein the total usage  
2 for each second device is a function of a total number of  
3 input/output messages directed to each second device  
4 multiplied by an expected connect time for the  
5 input/output messages.

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1 38. The apparatus of claim 37, wherein the expected  
2 connect time for the input/output messages is based on  
3 the type of input/output message being sent.

1 39. The apparatus of claim 30, wherein the controller  
2 accumulates a total path usage for each of the plurality  
3 of paths by sampling a number of input/output messages  
4 issued over each of the paths during a sampling period.

1 40. The apparatus of claim 32, wherein the path  
2 balancing device moves the second device from the highest  
3 path to the lowest path based on the calculated  
4 difference by changing address information for the second  
5 device.

1 41. The apparatus of claim 33, wherein the move limit is  
2 set to one half the plurality of paths.

1 42. The apparatus of claim 33, wherein if there is only  
2 one second device associated with the highest path,  
3 movement by the path balancing device of the one second  
4 device to the lowest path is prohibited.

1 43. A path balancing system in which path usage over a  
2 plurality of paths from at least one first device to a  
3 plurality of second devices is balanced, comprising:  
4 first means for accumulating a total path usage for  
5 each of the plurality of paths; and  
6 second means for performing path balancing if a  
7 difference between a total path usage of a path having a

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8 highest path usage and a total path usage of a path  
9 having a lowest path usage is more than a threshold usage  
10 amount.

1 44. The system of claim 43, wherein the second means  
2 performs path balancing by:

3 identifying a highest path from the plurality of  
4 paths, the highest path having a highest total path  
5 usage;

6 identifying a lowest path from the plurality of  
7 paths, the lowest path having a lowest total path usage;  
8 and

9 calculating a difference between the total path  
10 usage of the highest path and the lowest path.

1 45. The system of claim 44, wherein each of the  
2 plurality of second devices is associated with at least  
3 one of the plurality of paths and wherein the second  
4 means moves a second device from the highest path to the  
5 lowest path based on the difference.

1 46. The system of claim 45, wherein the second means  
2 does not move the second device if a number of moved  
3 second devices is equal to or greater than a move limit.

1 47. The system of claim 45, wherein the second device  
2 that is moved by the second means is the second device  
3 from the plurality of second devices that has a usage  
4 amount closest to a target amount.

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1 48. The system of claim 47, wherein the target amount is  
2 a fraction of the difference of the total path usage of  
3 the highest path and the lowest path.

1 49. The system of claim 43, wherein the total usage for  
2 each path is a function of the total usage for each  
3 second device associated with each path.

1 50. The system of claim 49, wherein the total usage for  
2 each second device is a function of a total number of  
3 input/output messages directed to each second device  
4 multiplied by the expected connect time for the  
5 input/output messages.

1 51. The system of claim 50, wherein the expected connect  
2 time for the input/output messages is based on the type  
3 of input/output message being sent.

1 52. The system of claim 43, wherein the first means  
2 accumulates a total path usage for each of the plurality  
3 of paths by sampling a number of input/output messages  
4 issued over each of the paths during a sampling period.

1 53. The system of claim 45, wherein the second means  
2 moves the second device from the highest path to the  
3 lowest path based on the calculated difference by  
4 changing address information for the second device.

1 54. The system of claim 46, wherein the move limit is  
2 set to one half the plurality of paths.

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- 1 55. The apparatus of claim 45, wherein if there is only  
2 one second device associated with the highest path,  
3 movement by the second means of the one second device to  
4 the lowest path is prohibited.